The Examiner notes that it is not clear how Applicant knows how Matsuyama contains 3% or more glass fiber as stated in Applicant's response filed 2/6/03. The Examiner further notes that if it is shown that Matsuyama does not in fact teach less than 3% glass fiber, it would have been an obvious matter of design choice to have used a top layer with a glass particle weight ratio of "less than 3%" as claimed, because Applicant has not disclosed that using a weight ratio of less than 3% provides a particular or unexpected advantage. The Examiner further asserts that one would have expected Applicant's invention to perform equally well with either the glass weight ratio taught by Matsuyama or the claimed "less than 3%" because both ratios perform the same function of reinforcing the top layer equally as well considering the size of the roll.

Rejections of the dependent claims are as follows. Claim 2 is rejected under 35 U.S.C. §103(a) as being unpatentable over Matsuyama. Claims 5 and 6 are rejected under 35 U.S.C. §103(a) as being unpatentable over Matsuyama in view of Yakushiji (JP 58017872 A). Claim 8 is rejected under 35 U.S.C. §103(a) as being unpatentable over Matsuyama in view of Ream et al. (6,284,373). Claim 8 is further rejected under 35 U.S.C. §103(a) as being unpatentable over Matsuyama in view of Tsukida et al. (5,450,181) and Takahashi et al. (6,132,815). Claims 9-11 and 14 are rejected under 35 U.S.C. §103(a) as being unpatentable over Matsuyama in view of Jinzai (5,572,275). Claims 12, 13, and 15 are rejected under 35 U.S.C. §103(a) as being unpatentable over Matsuyama in view of Jinzai as applied to claims 9, 10, and 14 above, and further in view of Ream et al. Claims 12, 13, and 15 are rejected under 35 U.S.C. §103(a) as being unpatentable over Matsuyama in view of Jinzai as applied to Claims 9, 10, and 14 respectively above, and further in view of Tsukida and Takahashi et al.

Applicant respectfully disagrees with this rejection, because not all of the claimed limitations are taught or suggested by the cited references. Applicant submits that the rejections of the dependent claims are subsequently overcome by overcoming the rejection over Matsuyama et al.

Applicant notes that the present invention discloses a fixing roller comprising a primer layer and a top layer, wherein glass particles are mixed into at least one of said primer layer and said top layer; and wherein a ratio of said glass particles to the top layer is a weight ratio of less than 3%. The present invention achieves both sufficient releasability and scratch-resistance simultaneously by mixing such a small amount (a weight ratio of less than 3%) of glass particles.

More specifically, Applicant notes that the top layer is made of a fluororesin, which has good releasability but does not have sufficient scratch-resistance. By mixing a small amount (less than 3 weight %) of glass particles into the top layer, the present invention can maintain the good releasability and improve the scratch-resistance.

In other words, when a weight ratio of glass particles is increased, the layer decreases in releasability. The mechanism is as follows: a fluororesin originally has good releasability from a fused toner, that is, a fused toner hardly adheres to a surface of a fluororesin. Further, a glass itself has poor releasability from a fused toner, that is, a fused toner easily adheres to a surface of a glass. Therefore, mixing glass particles will deteriorate releasability, depending on the amount of the glass particles added.

The inventor newly discovered a range of an appropriate weight ratio to have both sufficient scratch-resistance and releasability. If the weight ratio of the glass particles is less than 3%, scratch-resistance is significantly improved without deterioration in releasability for practical use.

On the other hand, Matsuyama focuses only on the fact that wear resistance of a fluororesin layer of a heat fixing roller is insufficient, and discloses its technology to mix glass fibers merely to improve the wear resistance. If the purpose is merely to improve the wear resistance, glass fibers in a weight ratio of as much as 25% are shown to be appropriate.

Applicant submits that the attached English translation of Matsuyama (57-172374) clarifies the above. Claim 2 of Matsuyama recites 3 weight% as the minimum rate of content of the glass fibers. As further mentioned in page 6, line 5 (in Japanese Publication, page 3, lower left column, last two lines), "it is also proved that the most preferable minimum fill rate of the glass fibers is 3%." Accordingly, it is clear that Matsuyama does not intend to include 3 weight % or less as the content rate of the glass fibers. Applicant notes that while the present invention might function with slightly more than 3 weight% glass particles, it is clear that Matsuyama et al. does not contemplate a composition comprising less than 3 weight% glass fibers, and therefore one skilled in the art would not have received a suggestion from Matsuyama et al. to incorporate less than 3% glass particles.

For at least the above reasons, Applicant submits that the present claims patentably define over the cited references. Withdrawal of the rejections and passage of the claims to issue at an early date is requested.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicant's undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed, Applicant respectfully petitions for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees that may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

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PATENT TRADEMARK OFFICE

Enclosures: English Translation of JP 57-172374

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Attachment A:

English Translation of JP 57-172374

Patent Laid-Open Publication No. 57 - 172374

Laid-Open Publication Date: October 23, 1982

Patent Application No. 56-058717

Filing Date: April 17, 1981

Assignee: Sumitomo Electric Industries, Ltd.

SPECIFICATION

1. TITLE OF THE INVENTION

THERMAL FIXING ROLLER FOR ELECTRONIC COPYING MACHINES OR THE LIKE

2. CLAIMS

(1) A thermal fixing roller for electronic copying machines or the like, comprising a metal roller having an outer surface covered with a fluororesin layer, wherein said fluororesin layer contains 25 weight% or less of glass fibers, relative to the fluororesin thereof.

(2) The thermal fixing roller as defined in claim 1, wherein the content of said glass fibers is in the range of 3 weight% to 25 weight% relative to the fluororesin thereof.

(3) The thermal fixing roller as defined in claim 1, wherein said glass fiber is a short fiber having an average length of 100 μ or less.

(4) The thermal fixing roller as defined in claim 1, wherein said glass fiber has a surface subjected to a treatment with a silane coupling agent.

(5) The thermal fixing roller as defined in claim 1, which said fluorochemical resin is ethylene tetrafluoride resin, or ethylene tetrafluoride- perfluoroalkoxyethylene copolymer.

(6) The thermal fixing roller as defined in claim 5, wherein said fluorochemical resin is ethylene tetrafluoride-perfluoroalkoxyethylene copolymer.

3. DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a thermal fixing roller for electronic copying machines, facsimile machines or the like.

A fixing process using a heating roller is known as a recent common process for fixing a toner image formed on a sheet in electrostatic electric copying machines or the like. This fixing process comprises supplying a sheet with a toner image formed thereon to pass through between a pair of rollers in press contact with one another, and heating one or both of the rollers from the inside thereof to fusion-bond the toner image on the sheet.

This roller type fixing process is used in most current electronic copying machines because of its various advantages such as higher heat efficiency and higher ability of facilitating a high-speed operation as compared to another fixing process using an oven. Typically, the fixing roller is made of metal, such as stainless steel or aluminum, and its surface is coated with an anti-offset material having a non-adhesive property or non-adherence, such as fluororesin or silicone rubber.

In these days, as the thermal fixing roller, most electric copying machines employ a roller coated with fluororesin such as ethylene tetrafluoride resin (hereinafter referred to as "PTFE resin" by brevity) or ethylene tetrafluoride-perfluoroalkoxyethylene copolymer (hereinafter referred to as "PFA resin" by brevity).

The thermal fixing roller coated with such a fluororesin has a problem of insufficient wear resistance.

More specifically, the thermal fixing roller is continuously in contact with a releasing pawl for releasing a sheet from the roller, a blade or felt for cleaning the surface of the roller, and a thermister for detecting the surface temperature of the roller. The fluororesin is worn away by these components, and the toner and sheet passing through a support roller and the fixing roller. Thus, after long-term use, the metal as a substrate will be undesirably exposed, resulting in

nullified effects of the fixing roller.

Through various researches on solutions of this problem, the inventor has finally accomplished the present invention.

The present invention is characterized in that glass fibers are added to the fluororesin at 25 weight% or less relative to the fluororesin.

It has been verified that this addition of the glass fibers is effective to improve the wear resistance and anti-scratch performance of the fixing roller, and is advantageous to provide an extended lifetime of the roller.

While the wear resistance is effectively improved only by adding a small amount, or about 1 %, of glass fibers, it is more preferable to add at 3 weight% or more to enhance the effect. On the other hand, if the content is greater than 25 weight%, the non-adherence of the surface will be reduced to a practically unacceptable level, which can lead to occurrence of offset or sheet jamming.

Preferably, the glass fiber to be added to the fluororesin has a short average length of 100 μ or less.

Specifically, glass fibers each having an excessively long length can be inhomogeneously dispersed over the fluororesin even at the same amount of addition.

Further, in the process of adding such glass fibers to the fluororesin, the surface of the glass fiber is preferably subjected to a treatment with a silane coupling agent, in advance. This is done to provide enhanced affinity between the fluororesin and a glass-based power so as to prevent the filler thereof from independently falling away due to wearing of the fluororesin used in a fixing roller.

The silane coupling agent is an organic silicide having two or more different reactive groups in its molecule, wherein one of the reactive groups is chemically bonded with an inorganic substance such as glass, and the other reactive group is chemically bonded with an organic material.

The fluororesin used therein is preferably ethylene tetrafluoride resin or ethylene tetrafluoride-perfluoroalkoxyethylene copolymer (hereinafter referred to as "PFA resin by brevity), or ethylene tetrafluoride-propylene hexafluoride resin (hereinafter referred to as "FEP

resin by brevity). Among them, PFA resin is particularly preferable.

PFA resin is selected because it has a higher heat resistance than that of FEP resin. In addition, while PFA resin has approximately the same non-adherence and heat resistance as those of ethylene tetrafluoride resin, it is hardly scratched when used in a fixing roller to provide longer lifetime of the roller as compared to ethylene tetrafluoride resin.

Thus, PFA resin is a most preferable resin to which the glass fibers are added.

A process for producing the above fixing roller will be described below. The surface of a metal roller serving as a substrate is roughened through sandblasting or etching to provide enhanced adhesiveness with fluorochemical resin. A primer may be additionally applied on the surface according to need to provide more enhanced adhesiveness.

The glass fibers can be blended with the fluororesin through a process of stirringly mixing glass fibers with a dispersion solution of fluororesin and then applying the obtained mixture through spraying, or a process of mixing glass fibers directly with resin powder as in PFA resin and then electrostatically spraying the obtained mixed powder. Either one of processes may be used.

The fluororesin added with the glass fibers is applied onto the outer surface of the metal roller subjected to the adhesiveness treatment, and heated up to its melting temperature or more. Through the above process, a fixing roller of the present invention can be produced.

After the above process, a finishing machining such as surface polishing may be additionally conducted according to need.

Examples of the present invention will be described below.

EXAMPLE 1

The surface of an aluminum roller (50 mmΦ) was roughened through sandblasting. PFA resin (MP-10 made by Mitsui Fluorochemicals) was stirringly mixed with powdered glass fibers (diameter: 13 μ, average length: 30 μ) each having a surface subjected to an aminosilane treatment, at the ratio as shown in Table 1.

This mixed powder was applied onto the surface of the roller at a thickness of 40 μ through an electrostatic powder coating process, and sintered, or fused/burnt, at 380°C for 20 minutes. Then, the roller was finished through surface polishing to have a surface roughness (average

roughness defined by JIB-B-0601) of 1 μ.

The finished roller was set up at a fixing section of a copying machine to fix a toner image on a sheet while maintaining the surface temperature of the roller at 180°C, and it was observed whether any offset occurred. The roller causing any petty offset was expressed by (×), and the roller causing no offset was expressed by (○). A crosscut peel test was also carried out to evaluate the adhesive force between the resin and the aluminum. This test has a process of making the number 100 of cross cuts each having a width of 1 mm and extending from the surface of the resin to the aluminum, with a knife, attaching a cellophane adhesive tape onto the surfaces, and immediately peeling the adhesive tape to check whether the surfaces cut with the knife are peeled.

The result is represented by a fraction in which the number of peeled surfaces among 100 crossed-cut surfaces is used as a numerator thereof. That is, 0/100 means no peeled surface, and 100/100 means that all of the surfaces were peeled.

Further, in order to evaluate the wear resistance as a fixing roller, a sheet-passing test using 50-thousand A-4 size sheets was carried out to evaluate the level of wearing of the resin in accordance with the reduced thickness of the resin.

The above results on occurrence of offset, adhesive force, and wearing level due to passing of sheets are shown in Table 1.

Table 1

No.	amount of added glass fibers	occurrence of offset	adhesive force	reduced thickness of resin in sheet-passing test
Comparative Example 1-1	0 %	○	0/100 (no peel)	4 to 5 μ
Inventive Example 1-1	3 %	○	0/100	2 μ or less
1-2	10 %	○	0/100	2 μ or less
1-3	15 %	○	0/100	2 μ or less
1-4	25 %	○	0/100	2 μ or less
Comparative Example 1-2	28 %	×	20/100	2 μ or less

As above, the fixing roller having the PFA resin added with the glass fibers can have a significantly enhanced wear resistance of the roller approximately without deterioration in non-adherence (occurrence of offset) of the surface of the roller as a fixing roller, when the fill rate of the glass fiber is 25 % or less.

It is also proved that the most preferable minimum fill rate of the glass fiber is 3%.

EXAMPLE 2

The surface of an aluminum roller (50 mmΦ) was roughened through electrolytic etching.

Then, powdered glass fibers (surface treatment with aminosilane, diameter: 13 μ, average length: 30 μ) were stirringly mixed with a dispersion solution of ethylene tetrafluoride resin.

This solution was applied onto the surface of the roller at a thickness of 25 μ through splaying, and burnt at 380°C for 25 minutes. Then, the surface of the roller was polished to have a finished surface roughness (average of roughness values at 10 points) of 1 μ.

The characteristics of the roller as a fixing roller were evaluated in the same way as that in EXAMPLE 1. These results are shown in Table 2.

Table 2

No.	amount of added glass fibers	occurrence of offset	adhesive force	reduced thickness of resin in sheet-passing test
Comparative Example 2-1	0 %	○	0/100	5 to 6 μ
Inventive Example 2-1	3 %	○	0/100	2 μ or less
2-2	10 %	○	0/100	2 μ or less
2-3	24 %	○	0/100	2 μ or less
Comparative Example 2-2	30 %	×	30/100	5 to 6 μ

As above, if ethylene tetrafluoride resin is alternatively used, it will effectively provide enhanced wear resistance.

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